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A Strategy for Efficient Device-Based Tank Gunnery Training in the Army National Guard

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A strategy is proposed for minimizing the device-based training time required to prepare armor crews of the U.S. Army National Guard for on-tank training and live-fire gunnery qualification. Using two devices (i.e., the Conduct-of-Fire Trainer [COFT] and Abrams Full-Crew Interactive Simulation Trainer [AFIST]), efficiency is achieved by training only gunnery engagements subjected to later live-fire evaluation, focusing on those engagements not performed to standard, and allocating training time to crews that need it most, as determined through pretesting. Guidance is provided to support strategy implementation at the company level and the conduct of research needed for future strategy refinement.

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Training Systems and Education

FOREWORD

The Army National Guard (ARNG) is seeking to place greater emphasis on the use of training devices to enhance the effectiveness and efficiency of home-station tank gunnery training. To help ensure the success of this approach, ARNG armor unit trainers need "how to" guidance on the use of specific devices to maximize the payoff from their usage. This report provides such guidance in the form of a device-based strategy designed to prepare ARNG tank crews for subsequent on-tank training and live-five gunnery qualification.

This research was conducted by the U.S. Army Research Institute for the Behavioral and Social Sciences Reserve Component Training Research Unit (USARI-RCTRU), whose mission is to improve the effectiveness and efficiency of reserve component training through use of the latest in training technology. The research task supporting this mission, "Train UP: Technology-Based RC Training Strategies," is organized under Science and Technology Objective III.Q.2, Unit Training Strategies.

The National Guard Bureau (NGB) sponsored this research under a continuing Memorandum of Understanding initially signed 12 June 1985. Results have been presented to Chief, Training Division, NGB; and Special Assistant to the Commanding General, U.S. Army Armor Center.

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A STRATEGY FOR EFFICIENT DEVICE-BASED TANK GUNNERY TRAINING IN THE ARMY NATIONAL GUARD

EXECUTIVE SUMMARY

Research Requirement:

To develop a strategy that minimizes the device-based training time required to prepare armor crews of the U.S. Army National Guard (ARNG) for on-tank training and live-fire gunnery qualification on Tank Table VIII.

Procedure:

The strategy was developed on the basis of past tank gunnery research findings reported since 1991 by the U.S. Army Research Institute for the Behavioral and Social Science's Reserve Component Training Research Unit.

Findings:

Using two devices (i.e., the Conduct-of Fire Trainer [COFT] and Abrams Full-Crew Interactive Simulation Trainer [AFIST]), efficiency is achieved by training only gunnery engagements subjected to later live-fire evaluation on Tank Table VIII, Focusing on those engagements not performed to standard, and allocation training time to crews that need it most, as determined through pretesting. Guidance is provided to support strategy implementation at the company level and the conduct of research needed for future strategy refinement.

Utilization of Findings:

The developed strategy will help ARNG armor unit trainers identify which crews to train, which devices to use, which gunnery engagements to present, and which proficiency standards to apply for achieving maximum payoff from the limited time available for device-based tank gunnery training.

A STRATEGY FOR EFFICIENT DEVICE-BASED TANK GUNNERY TRAINING IN THE ARMY NATIONAL GUARD

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A STRATEGY FOR EFFICIENT DEVICE-BASED TANK GUNNERY TRAINING IN THE ARMY NATIONAL GUARD

Background

In attempting to attain and maintain readiness standards comparable to their Active Component(AC) counterparts, U.S. Army National Guard (ARNG) combat arms units face serious challenges stemming from congressionally imposed limitations on training time (i.e.,12 Inactive Duty Training [IDT] weekends and 2 weeks of Annual Training [AT] per year [U.S. Army Training Board, 1987]). To maximize the payoff from the limited time available for training tank gunnery, for example, ARNG armor units plan to shift more of the training emphasis from a tank-based to a device-based approach (U.S. Army Armor School, 1990).

For this shift in approach to be successful, an efficient strategy is needed to help guide the design and execution of device-based tank gunnery training at the unit (i.e., company) level where such training typically is conducted. Issues requiring resolution include, for example, which device(s) to use, which training and evaluation exercises to conduct, and which proficiency standards to apply (Hagman & Smith, 1995).

Although several strategies have been developed in response to this need, they either do not provide the specific level of device usage guidance needed for standardized implementation (e.g., Headquarters, U.S. Army Training and Doctrine Command, 1992; Shaler, 1995), fail to promote efficiency by requiring either a full training calendar year to complete (e.g., Morrison, Campshure, & Doyle, 1991) or redundant use of devices (U.S. Army Armor Center, 1995), or fail to recommend sufficient device usage (U.S. Army Armor School, 1993). In addition, none rely on validated device-based performance standards.

The purpose of the present research, therefore, was to develop a tank gunnery training strategy for the ARNG that maximizes the efficiency of device usage, provides sufficient guidance to support standardized implementation, and promotes successful transition from device- to tank-based training and associated live-fire gunnery qualification through application of validated device-based performance standards keyed to expected live-fire gunnery performance. Efficiency is achieved by (a) emphasizing device-based training of only those gunnery engagements subjected to live-fire evaluation, (b) focusing on engagements not performed to standard, and (c) allocating training time to crews that need it most, as determined through pretesting.

Approach

Strategy development involved the identification of live-fire gunnery evaluation requirements, determination of device capabilities to support these requirements, and selection of a training and evaluation approach to support efficient device-based acquisition of tank gunnery skills.

Live-Fire Evaluation Requirements

A primary goal of ARNG armor unit commanders is to qualify as many tank crews as possible on Table VIII, a live-fire evaluation exercise fired annually for record by ARNG armor units to assess intermediate crew-level tank gunnery proficiency (Department of the Army, 1993). Table VIII consists of the six daytime (Table VIIIA) and six nighttime (Table VIIIB) engagements shown in Table 1. Of these 12 engagements, two (A5S and B1S) are "swing" engagements that may be fired day or night (depending on range conditions, time of year, etc.), and two (A5A and B5A) are alternate engagements that may be fired in place of A5S and B5. Thus, each tank crew fires only 10 of 12 possible engagements and must score 70 or more points on at least 7 out of the 10 engagements presented and fire a total score of 700 points or more out of a possible 1,000 to qualify. Because of its importance to crew-level gunnery evaluation and the overall assessment of unit combat readiness, successful Table VIII qualification was adopted as the terminal objective of strategy development.

Device Capabilities

Two training devices available to ARNG armor units at their home-station armories were selected for inclusion in the strategy: the Conduct-of-Fire Trainer (COFT)(U.S. Army Armor Center, 1991) and the Abrams Full-Crew Interactive Simulation Trainer (AFIST) (Computer Sciences Corporation, 1995). Both devices allow crews to use realistic tank controls in response to computer-generated images displayed through tank optics. They differ, however, in certain respects.

The COFT, for example, is a standalone, computer-based device designed to support the gunnery training of tank commander (TC) and gunner pairs within the confines of a simulated tank crew compartment, with inputs from the remaining crew members (i.e., driver and loader) simulated by an instructor/operator (I/O). In contrast, the AFIST is appended to a stationary tank to support full-crew training, although the loader and driver simulations are of considerably lower fidelity than the TC and gunner simulations (Campshure, 1991; Morrison & Hagman, 1994). COFT also simulates all three M1/M1A1 tank weapon systems (main gun,

coaxial machine gun, and Caliber .50 machine gun), whereas AFIST simulates all but the Caliber .50 machine gun.

Table 1

Description of Table VIII Engagements

Engagement	Description
	Table VIIIA (Day)
A1	On defense, engage a moving and a stationary tank with main gun using the gunner's auxiliary sight (GAS) and battlesight gunnery.
A2	On defense, simultaneously engage a stationary BMP (tracked armored personnel carrier [APC]) with main gun and a stationary BTR (wheeled APC) with TC's Caliber .50 machine gun.
A3	On offense, engage two sets of troops with coaxial machine gun using precision gunnery.
A4	On offense and under nuclear, biological, and chemical (NBC) protection status, engage two stationary tanks with main gun using precision gunnery.
A5A	On offense, engage stationary and moving tank with main gun using precision gunnery.
A5S	On offense, engage two moving tanks with main gun using precision gunnery.
	Table VIIIB (Night)
B1S	On defense, engage a stationary tank with main gun from a three-man crew configuration using precision gunnery.
B2	On defense, engage two stationary BMPs with main gun using precision gunnery.
B3	On offense and under NBC protection status, engage a stationary BMP with main gun and a stationary rocket-propelled grenade launcher (RPG) team with coaxial machine gun using precision gunnery.
B4	On offense, engage a stationary and moving tank with main gun using precision gunnery.
B5	On defense, engage a stationary tank with main gun using GAS battlesight gunnery under external illumination.
B5A	On defense, engage a moving tank with main gun using precision gunnery.

Both devices feature a software-driven matrix of training and evaluation exercises. Although structured differently, both matrices support presentation and automated scoring of various Table VIII-related target engagement exercises depicted on either simulated European or desert terrain (U.S. Army Armor Center, 1991). A matrix progression algorithm allows crews to advance from one exercise to the next, in a lock step fashion, contingent upon demonstrated gunnery proficiency. Both devices' algorithms can be overridden, however, to enable random access to any exercise, a capability needed to implement the proposed strategy.

Training and Evaluation Exercises

The training exercises on each device permit TC and gunner (COFT) and full-crew (AFIST) engagement of single and multiple targets under fully operational (i.e., precision gunnery) and degraded mode (e.g., inoperative laser range finder) firing conditions. The COFT training exercises are separated into four groups. Unlike AC tank crews, ARNG tank crews are not required to fire the training exercises in Groups 2-4 before undergoing live-fire Table VIII evaluation; thus, only exercises contained in Group 1 (i.e., 101-120) were considered for strategy adoption. Table 2 shows which of these exercises simulate the targeting conditions of Table VIII engagements. The COFT exercises 113 and 117, for example, present defensive, GAS-based, main gun engagements similar to that fired on Table VIII engagement A1.

Table 2

COFT and AFIST Training Exercises Corresponding to Table VIII Engagements

Table VIII Engagements	COFT Training Exercises	AFIST Training Exercises
A1	113, 117	6AT1
A2	101, 111	--
A3	102, 106	6AT2
A4	102, 106, 110	6AT3
A5S	102, 106, 110	6AT4
A5A	102, 106, 110	6AT5
B1S	103, 107, 119	6BT1
B2	105	6BT2
B3	110	6BT3
B4	102, 106, 110	6BT4
B5	113, 117	6AT1
B5A	105	6BT5

Group 1 of the COFT matrix also includes 16 evaluation exercises (i.e., 130-145) that contain a different selection and random ordering of the actual engagements fired on Table VIII. Some evaluation exercises, for example, include engagement B5, whereas others include B5A. In addition, engagement A5A is not simulated at all. Engagements A5S and A5A, however, are similar in their targeting conditions, thereby eliminating the need for their separate representation.

The AFIST matrix contains six groups of training and evaluation exercises similar in content to those found on the COFT matrix. To promote efficiency, only the training exercises in Group 6 that simulate actual Table VIII engagements (Computer Sciences Corporation, 1995) were used in strategy development. Table 4 shows that AFIST exercise 6A2, for example, supports the training of offensive, coaxial machine gun-based engagements of troop targets as required by engagement A3 of Table VIII. Because AFIST does not simulate the Caliber .50 machine gun, it cannot be used to train or evaluate Table VIII engagement A2.

The Proposed Strategy

Given identification of the specific engagements fired on Table VIII and the capability of COFT and AFIST to simulate these engagements, the following strategy is proposed to guide tank crew training and evaluation of Table VIII-related engagements on each device.

Pretesting

As shown in Figure 1, the strategy begins with a pretest on COFT. The purpose of this pretest is to (a) assess tank crew proficiency on simulated Table VIII engagements, and (b) identify those engagements not performed to standard and, therefore, in need of training. Theoretically, pretesting could also be conducted on AFIST, given that it also contains a Table VIII evaluation exercise as part of matrix Group 6. To date, however, the relation between simulated Table VIII performance on AFIST and actual Table VIII performance on the range has not been determined. As a result, pretesting must be conducted on the COFT, where the relation between device and live-fire performance has recently been described (Hagman & Smith, 1996).

The COFT-based pretest that we recommend for strategy adoption was developed and validated by Hagman and Smith (1996) for the purpose of predicting the probability of first-run Table VIII qualification. The test consists of four 10-engagement evaluation exercises (i.e., 131, 132, 133, and 134) from Group 1 of the COFT training and evaluation matrix. To promote

standardization of testing, the exercises are fired in ascending order without feedback from the I/O (except for sector adjustments), with crews given a 5 min rest period after each of the first three exercises. The scores for the four test exercises are then added (after subtracting points for procedural errors, such as attempting to fire the main gun before it is safely armed or not firing first at the most dangerous target during a multiple target engagement) and divided by four to obtain a mean COFT pretest score from 0-1,000 points. This pretest score is then used to predict the probability of tank crew first-run qualification on Table VIII.

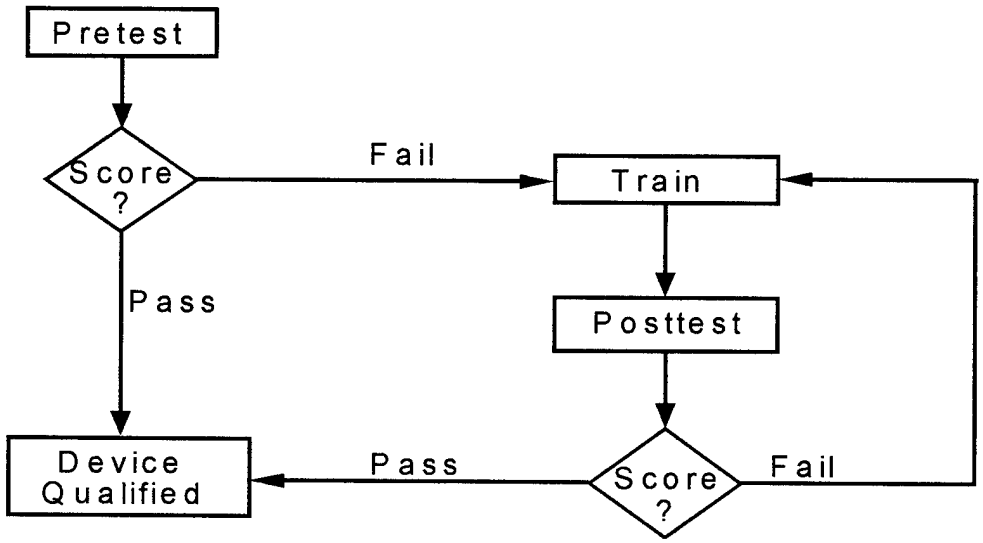

Figure 1. Flowchart depiction of strategy

Table 3 depicts a selected range of potential COFT pretest scores (column 1) along with each pretest score's predicted mean Table VIII score (column 2) and associated probability of first-run Table VIII qualification (column 3). Use of this table enables a unit commander to predict that a particular crew obtaining a COFT pretest score of 765, for example, will on the average fire 700 on Table VIII and have a 50% chance of actual first-run qualification. Depending on whether pretest scores fall above or below the standard for Table VIII qualification (e.g., 50%) set by the unit commander, some crews will be device qualified, whereas others will be device unqualified.

Training

As shown in Figure 1, only device-unqualified crews receive device-based training under the proposed strategy. Thus, training time is devoted only to those crews lacking in gunnery proficiency, thereby promoting efficient allocation of the time available. To promote further efficiency, training is restricted only to individual engagements not performed to pretest standard

(i.e., the pretest criterion score [or standard] set by the unit commander divided by 10, the number of engagements fired per exercise). For a pretest criterion score of 861, for instance, an average score (calculated by adding the four scores for a specific engagement and then dividing by four) of < 86.1 on any single engagement would be considered substandard and the engagement in need of training. Unlike pretesting, training can be conducted on either COFT or AFIST, except for the training of simultaneous engagement A2 that must be conducted on COFT because AFIST does not simulate the needed Caliber .50 machine gun.

Table 3

Predicted Tank Crew Table VIII Score and Probability of First-Run Qualification for Selected COFT Pretest Scores

620	562	10%
669	609	20%
706	644	30%
737	673	40%
765	700	50%
793	727	60%
824	756	70%
861	791	80%
910	838	90%

Note. From "Device-Based Prediction of Tank Gunnery Performance," by J. D. Hagman and M. D. Smith, 1996, Military Psychology, 8, p. 66. Copyright 1996 by Lawrence Erlbaum Associates, Publishers. Reprinted with permission.

Except for under the most stringent pretest criteria (e.g., > 900) set by the unit commander, device-unqualified crews will need training on more than one type of Table VIII engagement to achieve qualified status. Although the order in which these engagements is trained is likely to influence efficiency because of differential transfer effects, little is known about the nature and extent of these effects for Table VIII engagements. As a result, we recommend that engagement training follow the traditional easy-to-difficult progression.

Table 4 shows the difficulty rating of each Table VIII engagement, as found by Hagman (1994) in his empirical analysis of the live-fire performance of 109 ARNG armor tank crews. Using

this table, unit trainers should proceed with the training of engagements A1, A3, and B1S, for example, in the order B1S, A1, and A3. Although we do not know if an easy-to-difficult progression is indeed the most efficient, it should lead to effective acquisition and transfer of enabling skills (e.g., proper reticle aim) needed for successful performance of more difficult engagements. It should also be accepted well by ARNG trainers who have become accustomed to training under such an approach in the past.

Table 4

Difficulty Rankings of Table VIII Engagements

Table VIII Engagement	Difficulty Ranking
A3	1
B3	2
A2	3
A1	4
B2	5
A4	6.5
B4	6.5
B5	8
A5S	9
A5A	10
B5A	11
B1S	12

Note. 1 = most difficult

As shown in Table 2, COFT can be used to train all Table VIII engagements, whereas AFIST can be used to train only a subset (because of the missing Caliber .50 machine gun). When both devices are capable of supporting the training of a particular Table VIII engagement (e.g., B1), we recommend that AFIST be used as the device of choice because of its ability to involve all four crew members during the engagement, thereby promoting full-crew integration in the process. Regardless of the device used, when two or more exercises are identified for the training of a particular Table VIII engagement (e.g., A3), trainers should alternate between or among exercises to enhance variety and facilitate transfer (Schmidt & Young, 1987).

We recommend that a provisional standard for crew proficiency on training exercises be set at two successful criterion performances. On the COFT, criterion performance is achieved

upon crew receipt of an "advance" recommendation from the device in the areas of target acquisition, reticle aim, and system management, as provided on the performance analysis printout. On the AFIST, criterion performance is achieved upon crew receipt of a "pass" recommendation from the device for the exercise being trained.

Posttesting

As a final step, crews that have completed training must be posttested (i.e., by refiring the pretest) to ensure that device-based proficiency has been achieved. Crews passing the posttest are considered device qualified, whereas those failing the posttest must repeat device-based training as outlined above.

Implementation Considerations

The proposed strategy is designed for unit implementation over three (preferably consecutive) drill periods. To promote efficiency, we recommend that pretesting be conducted during IDT in conjunction with administration of the Tank Crew Gunnery Skills Test (TCGST), the test used to certify crew member proficiency on basic gunnery tasks (e.g., identify armored vehicles, load main gun ammunition, issue fire commands). According to Hagman and Smith (1996), pretesting will take 60-90 min per crew. If insufficient time is available to pretest all crews during TCGST administration, then additional time should be provided through use of 4-hr Readiness Management Assemblies (RMAs) often reserved for gunnery training of individual crews outside of monthly scheduled unit drill periods.

Before the first scheduled drill after pretesting, pretest performance should be reviewed for the purpose of identifying device-unqualified crews and selecting the appropriate Table VIII-related engagement(s) for training (i.e., those not performed to standard on the pretest). Similarly, the training results of this and the following two drill periods should be reviewed to select the appropriate exercises for training crews yet to qualify for posttesting, and to posttest those that have successfully completed training.

Once all crews have achieved device-qualified status by passing the pre- or posttest, on-tank training should begin either with (a) the Tank Crew Proficiency Course (i.e., Table IV) and proceed as prescribed in FM 17-12-1-2 (Department of the Army, 1993) or (b) Combat Table I and proceed as prescribed in the Enhanced Mounted Brigade Training Strategy (U.S. Army Armor Center, 1995), or with (c) an AFIST-based Table IV and proceed as prescribed in the Compressed Gunnery Program proposed under Project SIMITAR (Simulation in Training for Advanced Readiness)

(Shaler, 1995). Regardless of which approach is adopted, on-tank training is essential for crews to experience the different aspects of gunnery not practiced or simulated on devices, yet important for successful Table VIII qualification (e.g., open-hatch target acquisition, misfire procedures, tank movement and gun recoil effects, and safe handling of heavy main gun ammunition).

Discussion

The strategy just described suggests a number of ways for promoting efficient use of the device-based training time required to prepare ARNG armor crews for on-tank training and subsequent live-fire gunnery qualification on Table VIII. Using COFT alone or in combination with AFIST, time is saved by restricting the scope of device-based training to only engagements subjected to Table VIII evaluation, and then only to that subset not fired to the pretest standard set by the unit commander. In addition, by excusing device-qualified crews (i.e., those passing the pretest) from further training on devices, training time can be spent on crews that need it most. Posttesting then ensures that previously device-unqualified crews have attained the level of proficiency required for successful transition to on-tank training and live-fire gunnery.

In attempting to streamline device-based training, it might be argued that the proposed strategy recommends "teaching the test" in order to boost Table VIII qualification rates, and that crew gunnery involves more than proficiency on just the limited number of engagements fired on Table VIII. While we would agree that Table VIII does not represent an exhaustive set of gunnery engagements needed to survive and win on the battlefield, it does, however, contain the array of engagements judged appropriate for certification of intermediate crew-level tank gunnery proficiency (Department of the Army, 1993). Given the present training time constraints and yearly gunnery evaluation demands placed on most ARNG armor units, it seems reasonable that the emphasis of device-based training should be placed on engagements that impact this certification as opposed to those that do not. Such a strategy will maximize the payoff from the device-based training time invested without compromising existing live-fire performance goals.

In attempting to save time, the proposed strategy recommends that the training and evaluation matrices on COFT and AFIST be used in ways not originally intended. Traditionally, crews start training on the easier engagements (e.g., engagement of a single stationary target from a stationary tank) found early in each matrix and proceed to the more difficult engagements (e.g., engagement of multiple moving targets from a moving tank) found

toward the end of each matrix. Unfortunately, most crews run out of training time under this traditional approach and undergo little if any device-based training on the more difficult engagements required for Table VIII qualification.

In contrast, the proposed strategy allows crews to move about within each matrix on the basis of demonstrated proficiency, thereby allowing training time to be focused on engagements not performed to standard (i.e., on the pretest). In doing so, time is not wasted on training engagements that crews are already proficient at performing.

Although the primary purpose of strategy development was to provide ARNG unit commanders and trainers with detailed guidance on how to implement efficient and effective device-based training, the development process has uncovered several areas in need of further investigation. For example, a prediction tool similar to that developed for the COFT (Hagman & Smith, 1996) needs to be developed for the AFIST. This would enable AFIST to be used for pre- and posttesting, as well as for training, and allow units to proceed with strategy implementation at times when both devices are not available. Currently, training can be done on either device, but pre- and posttesting must be done on the COFT.

Research is also required to determine the need for strategy refinement in certain areas. It is unknown, for example, whether or not (a) two successful criterion performances during training are sufficient to ensure crew passage of the posttest, (b) an easy-to-difficult training approach is most efficient for Table VIII-related engagements, and (c) strategy implementation can be effected in the amount of time anticipated (i.e., 60-90 min for pretesting plus three drill weekends for training and posttesting). Until these issues are resolved, the above strategy is proposed to help ARNG armor unit trainers identify which crews to train, which devices to use, which engagements to present, and which proficiency standards to apply for achieving maximum payoff from the limited time available for device-based tank gunnery training.

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